VEGETATION RESPONSE TO SLASHBURNING: A 3-YEAR PROGRESS REPORT

INTEGRATED WILDLIFE INTENSIVE FORESTRY RESEARCH

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VEGETATION RESPONSE TO SLASHBURNING: A 3-YEAR PROGRESS REPORT

by

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ABSTRACT

This report documents initial findings on the response of vegetation to different intensities of slashburning on fire-sensitive sites. The study sites were 3-year-old clearcuts at mid-elevation on Vancouver Island, British Columbia. Two fire intensities plus an unburned comparison were replicated in a balanced, incomplete block design. Ocular estimates of percent cover of all ground forage were conducted prior to treatment and 1 and 2 years after burning.

The unburned treatment showed increases in virtually all species over the three sampling periods. Most species that survived the burn also increased in ground coverage by the 2nd year after burning. Post-burn abundance of shrubs and conifer seedlings was significantly lower than before the burn, although mean treatment differences were significant only for red huckleberry (Vaccinium parvifolium). Both burn intensities, however, eliminated all amabilis fir and western hemlock seedlings. Post-burn shrub cover values were consistently higher on a light impact burn than on a heavy impact burn. Evergreen shrub coverage (mainly salal (Gaultheria shallon) and dull Oregon-grape (Mahonia nervosa)) reached pre-burn levels in the 2nd year after treatment on a light impact burn, while attaining only 16% of pre-burn abundance on a high impact burn. In contrast, burning appeared to have little effect on herb abundance. Herb cover increased each year, but only one species (Mycelis muralis) showed significant treatment differences. Fireweed (Epilobium angustifolium) was the most abundant herb, with significant annual increases in ground coverage, but other species were also invading the sites.

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1 INTRODUCTION

In an overview of forest succession research, Franklin (1982) identified manipulative experiments and models of early successional stages as being two key needs in future research. The same needs are pertinent to black-tailed deer (Odocoileus hemionus columbianus) habitat management. Since large-scale logging began in the forests of Vancouver Island, British Columbia, black-tailed deer have been using clearcuts as spring and summer foraging areas. In fact, Cowan (1945) postulated that logging enabled deer numbers to increase far beyond the level present in unlogged forests. During spring, Gates (1968) found that deer preferred seral stages with the greatest variety and quantity of herbaceous food, namely early regenerating clearcuts. He also hypothesized that sustained deer populations could only be achieved if the area of land under early successional development was maintained. At present, many Vancouver Island watersheds are covered in even-aged young-growth forest and the scarcity of spring foraging areas is becoming a management concern.

Slashburning on coastal British Columbia clearcuts is often an integral part of the process of establishing a new forest. Whether it is used to reduce slash loading, create plantable sites, or control competing vegetation, the prescribed fire has immediate impacts on site vegetation. However, the extent of this impact on the long-term spring forage potential of a site is unclear.

In 1984, MacMillan Bloedel (MB) and the Canadian Forestry Service (CFS) began a co-operative project designed to measure both short-term and long-term effects of fire on tree growth and site productivity. By invitation, the Integrated Wildlife-Intensive Forestry Research program (IWIFR) also became involved in the study, since it gave IWIFR staff a chance to examine fire-induced changes to vegetation production under fairly controlled conditions. A forage sampling scheme was subsequently designed and implemented. Changes in abundance and diversity of the clearcut vegetation in response to slashburning intensity and time are presently being monitored.

This report describes the findings of the first 3 years of the project, including pre-burning values and the results of the 1st- and 2nd-year post-treatment vegetation sampling. Impacts of slashburning on blacktailed deer spring forage are not addressed here.

1.1 Objective and Study Area

The objective of the study is to describe vegetation response to different intensities of slashburn during the first 10 years after burning, and to evaluate the impact of this on the abundance of black-tailed deer spring forage.

The study is located west of Port Alberni, B.C., within MacMillan Bloedel's Sproat Lake Woodlands Division. Three clearcuts were selected (Figure 1) on comparable sites within the wetter maritime subzone of the Coastal Western Hemlock biogeoclimatic zone (CWHb). Time since logging varied from 2 to 3½ years between areas. Plots were located between 455 and 600 m elevation, on moderately steep, southerly aspects. A more detailed description of site variables (soils, edatope, and topography) is provided in Beese (1986).[1]

1.2 Study Design

The trial was initiated as a balanced incomplete block design in which different pairs of treatments were randomly allocated to the three blocks (sites). The three treatments include a light impact burn, a heavy impact burn, and an unburned control.[2] The light burns were targeted to remove less than 50% of the organic matter on site; the heavy burns were designed to remove over 50% of the organic matter. To achieve the desired fire intensities, the light burn treatments were conducted in the spring and the heavy burn treatments in the fall. Table 1 provides a list of treatment dates and a calendar of completed sampling activities and proposed activities.

Before burning, five plots were established within each treatment unit by MB project staff. For simplicity, IWIFR sampling was limited to only a few of these plots. To avoid interference with other sampling efforts, measurement was not possible in certain plots and was restricted in others. Because of time restraints, IWIFR staff sampled four plots on each of the control and heavy burn treatments, and six on the light burn treatment. Table 2 shows the resultant post-treatment distribution of samples.

1.3 Techniques

The plots are equilateral triangles with sides 30 m long (actual distance, uncorrected for slope). The triangular shape was used to limit the problem of plot sides coinciding with the orientation of logging debris or with disturbance patterns resulting from logging activities. A single cornerpost was located and the bearing to the second corner was determined with a random number table. The plot was subsequently established with the lowermost corner labelled "A", the next corner counter-clockwise labelled "B", and the third corner labelled "C".

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[1] Beese, W.J. 1986. Effects of prescribed burning on forest productivity of some coastal B.C. sites. MacMillan Bloedel Ltd.,Nanaimo, B.C. Unpublished report.

[2] Beese (1986) used the terms "low intensity" and "high intensity" to describe the two burns.

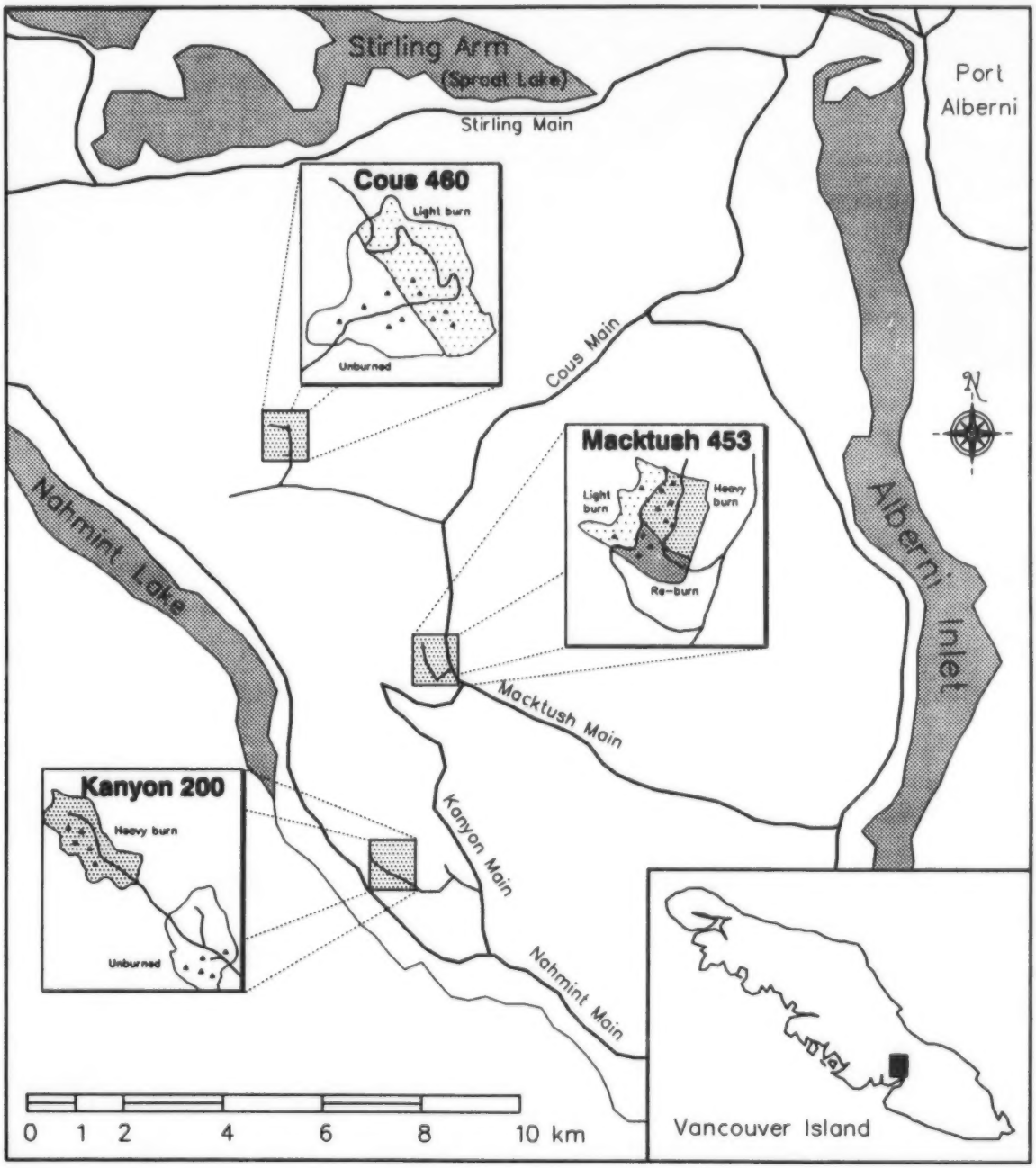

FIGURE 1. Location of the Sproat Lake study sites.

TABLE 1. Calendar of events for the Sproat Lake slashburn study

Date	Activity
April 1985	- introduction to the project - development of IWIFR sampling scheme
May 1-2, 1985	- IWIFR pre-treatment sampling of light burn plots
May 21, 1985	- ignition of Cous and Macktush light burns
May 27-29, 1985	- completion of IWIFR pre-treatment sampling (control and heavy burn plots)
September 25, 1985	- ignition of Kanyon heavy burn
October 5, 1985	- ignition of Macktush heavy burn (and accidental re-burn of several light burn plots)
March 14-21, 1986	- all treatment units planted
September 23-25, 1986	- first IWIFR post-treatment sampling
September 22-24, 1987	- second IWIFR post-treatment sampling
April 1989	- completion date of first progress report
	Future Activities
September 1989	- third sampling scheduled
September 1991	- fourth sampling scheduled
April 1993	- completion of second progress report
September 1993	- fifth sampling scheduled
September 1995	- final sampling scheduled
April 1996	- completion of final project report

TABLE 2. Post-treatment plot distribution in the Sproat Lake slashburn study[a]

Treatment	Area		
	Cous Cr.	Kanyon	Macktush
Unburned	2	2	n.a.[b]
Light burn	3	n.a.	1
Heavy burn	n.a.	2	2
Re-burn	n.a.	n.a.	2

[a] Each plot contains 20 subplots.
[b] Not applicable since the area/treatment combination was not present.

At each of the three areas, five triangular plots were established in each treatment unit. They were systematically numbered from 1 (lowermost) to 5 (uppermost plot on the slope).

The plots were subsampled with a 0.25 m^2 frame (quadrat). Quadrat position was systematically determined within the triangular plots (Figure 2). Five sampling lines were established at 5-m intervals along the A-B boundary of the triangular plot, paralleling the A-C boundary. On each line, points were located 3 m from the A-B boundary and at 3-m intervals across the plot. This resulted in 20 subplots per triangular plot. If a sampling point was to fall on an erosion-assessment station,[3] it was shifted to the nearest unoccupied metre position further along the sampling line. The locations were marked using 5-inch (12.5 cm) steel spikes. Fluorescent pink flagging tape was attached to the spikes to make relocation easier. Appendix 1 lists the modifications made to sample location and data collection procedures. The abundance of clearcut vegetation was assessed through ocular estimates of percent cover within the quadrats (subplots). Cover estimates were in multiples of five, except at the low end of the scale (< 10%) where estimates were made to the nearest percent.

Estimates of woody fuel abundance and ground coverage of rock were also recorded according to percent cover estimates. Although collected to provide an indication of available rooting space, these two measures also became indices of fire intensity on the burns. Detailed observations on pre- and post-burn fuel abundance, weather conditions, and other important fire-related variables were collected by other researchers.[4]

In addition to cover estimates, shrub abundance was also evaluated through stem counts (for Mahonia nervosa), stem length (for evergreen ferns and Vaccinium spp.), and basal stem diameters (for all woody species except Mahonia nervosa). Dial calipers were used to measure basal stem diameters, with measurements recorded to the nearest 0.1 mm. Stem lengths were recorded to the nearest 5 cm.

1.4 Analysis

Examination of the design implemented in the study (as modified by IWIFR sampling) indicated that only treatment, year, and treatment-by-year effects were readily testable.

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[3] See Beese, 1986.
[4] Details are provided in Beese, 1986.

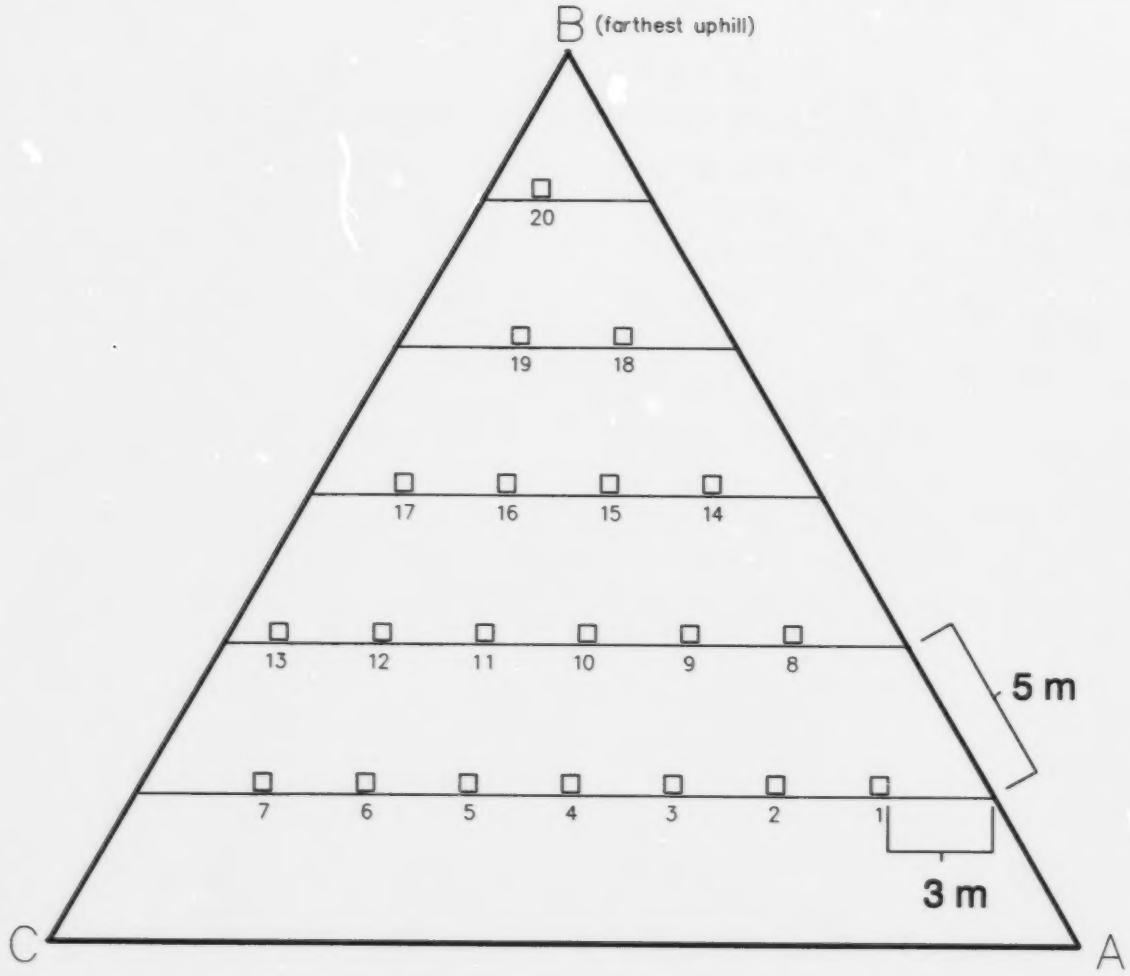

FIGURE 2. Plot diagram and distribution of subplots (quadrats).

Although plot and plot-within-year variance could be tested, limitations in computer memory prevented evaluation of their significance.

The experimental design was converted into an unbalanced incomplete block design (Hicks 1973) because of the accidental creation of an additional burn treatment (the re-burn) and the corresponding loss of light burn samples. The analysis was complicated by the resultant unequal distribution of light burn plots between the two replicates. The procedures required to analyze this design properly were considered to be too complicated for this preliminary report, so the re-burn data were ignored and analysis was conducted on the original treatment data only, following procedures outlined by Milliken and Johnson (1984). The three different years of measurement were considered to be split plots of the main plots (burns), with plots nested within the burns and quadrats nested within the plots. A breakdown of sources of variation and error terms used in the analysis of variance is provided in Table 3.

Normality testing indicated that the raw data were non-normally distributed for all species examined. An arcsine transformation was unable to provide significant improvement. This is not surprising, given the large number of zeros in the data. Species with low frequency of occurrence were almost always normally distributed when only non-zero data values were used.

Examination of the data also indicated that the variances of percent cover values for many species were proportional to the mean (the data were heteroscedastic). A logarithmic transformation ($\log[x+1]$) was implemented to solve this, but it failed to correct the problem of non-normality.

To avoid the problems of heteroscedasticity and non-normality, tests for significant effects in the analysis of variance were performed on ranked data values as well as on raw data. Iman (1982) concluded that the use of ranks was a sound alternative when various basic assumptions could not be guaranteed. Orthogonal contrasts were used to evaluate treatment and year effects. Effects were judged to be significant if the Type I error was 0.1 or less ($\alpha \leq .10$). The treatment-by-year interaction has not been fully evaluated; full analysis will be presented in future reports. However, the post-treatment component of the interaction was examined. Where this component was not significant and the overall interaction was, a significant response to the burns can be assumed. Where differences existed between ANOVA's on the raw and ranked data, the ranked results were considered

to be more reliable since the distribution-free rank transformation is not affected by non-normality.

Although re-burn data were not incorporated because of the complexity they introduce into the analysis, re-burn values are described in the results. All data are expected to be used as data collection continues.

All analyses used SAS/STAT (SAS 1985), a PC-based statistical package.

TABLE 3. Sources of variation and error terms incorporated in the analysis of variance

Source of variation		df	Error term
Blocks	B	2	M(BT)*
Treatment	T	2	BT
(1) control vs burns		1	BT
(2) light vs heavy		1	BT
B x T interaction	BT	1	M(BT)*
Main plot	M(BT)	0	Q(PMBT)*
Plot	P(MBT)	6	Q(PMBT)
Quadrat	Q(PMBT)	228	-----*
Year	Y	2	BY
(1) pre- vs post-		1	BY
(2) 1986 vs 1987		1	BY
T x Y interaction	TY	4	BTY
B x T x Y interaction	BTY	6	YM(BT)*
	YM(BT)	0	YP(MBT)*
	YP(MBT)	12	YQ(PMBT)
	YQ(PMBT)	456	-----*
Total		719	

* Asterisks indicate non-testable expressions.

2 RESULTS

2.1 Slashburn Intensity

The fire impact objectives of the study were to obtain less than 50% duff consumption on the light impact burn and to obtain more than 50% consumption on the heavy impact burn. These objectives were met.[5] For the subsample of plots used in the forage study, the specified burning levels were also achieved (Table 4), although one heavy impact burn plot had only 45.2% duff consumption. The combined coverage of fresh woody debris and old decaying wood was examined in this vegetation study to provide one index of burn impact. As a second measure of fire intensity, the amount of surface rock and exposed mineral soil was also recorded.

As expected, the amount of woody material remaining after treatment was greatest in the unburned plots and least in the re-burn plots (Figure 3); and the proportion of woody debris burned corresponded to treatment intensity for the two planned burns. Debris reduction on the light and heavy burns averaged 37 and 57%, respectively. However, the re-burn plots averaged 31% woody material before burning and 17% during the first post-treatment sampling, a reduction of only 46%. Over this same period, a 13% decrease was recorded on the unburned plots. Analysis of variance in the data indicated a significant year

TABLE 4. Mean percent consumption of woody fuel and duff[a]

Treatment	% Woody fuel consumed	% Duff consumed
Unburned	-	-
Light burn	41	35.5
Heavy burn	50	72.4
Re-burn	76	86[b]

[a] W. Beese (pers. comm.).
[b] An average of three plots, not two.

[5] Beese, 1986.

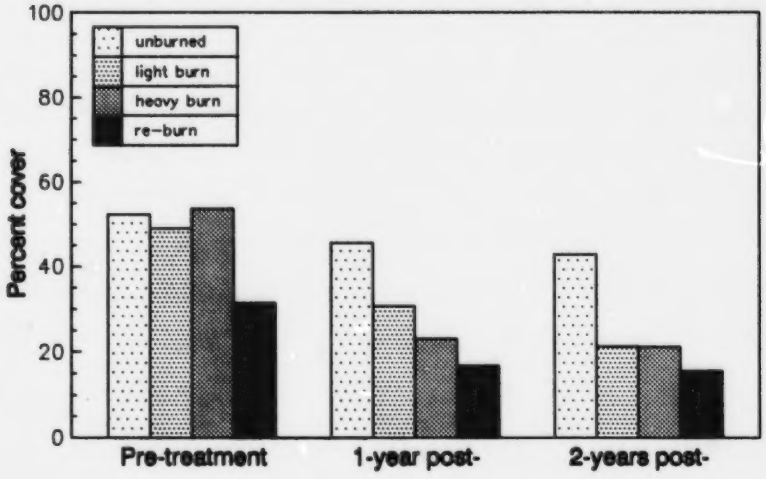

FIGURE 3. Percent cover of woody material during the first 3 years of sampling on the four treatments.

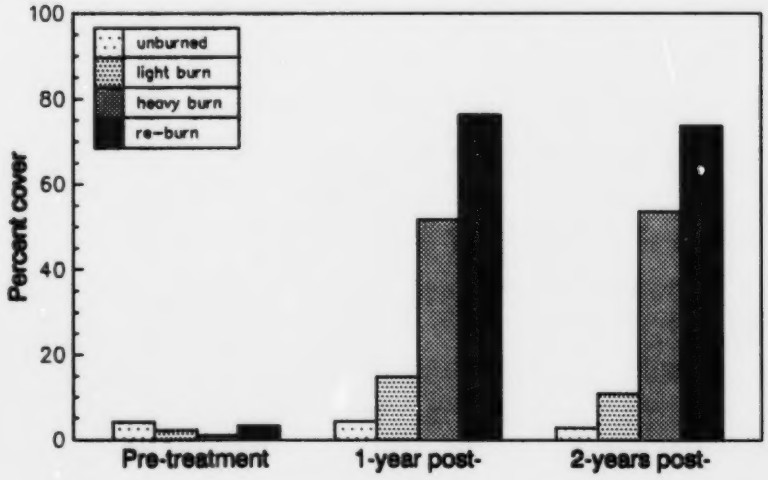

FIGURE 4. Percent cover of rock and exposed mineral soil during the first 3 years of sampling on the four treatments.

TABLE 5. Probability values for components of variance in ranked data for selected species and species groups[a]

Species code	Treatment[b]		Year[c]		Interaction	
	C vs L+H	L vs H	Pre- vs Post-	1986 vs 1987	All years	Post only
Woody material	.3743	.9266	.0001	.0567	.0193	.6825
Exposed soil and rock	.0294	.0332	.0001	.1138	.0006	.8016
Conifers	.3732	.9543	.0491	.6749	.1604	.9602
ABIEAMA	.3790	.9480	.0137	.7923	.2084	.9291
Deciduous shrubs	.0336	.2232	.0884	.4873	.0634	.9701
VACCALA	.2296	.5462	.0616	.7806	.6211	.9765
VACCPAR	.0403	.1779	.0993	.3384	.0295	.7821
Evergreen shrubs	.6905	.4435	.0327	.0603	.0036	.8623
GAULSHA	.9177	.4180	.0010	.0611	.0007	.6691
MAHONER	.9905	.5499	.0938	.0978	.0443	.5484
Herbs	.2895	.7307	.0003	.0390	.5042	.9157
ANAPMAR	.5542	.4489	.2608	.3023	.5646	.5308
EPILANG	.2818	.4794	.0012	.3282	.8128	.8752
HYPORAD	.6870	.3985	.0457	.0860	.5050	.9687
MYCEMUR	.0479	.0463	.0718	.0180	.6418	.4362
SENEVUL	.4021	.2630	.0319	.1342	.1091	.2955

[a] Re-burn data were excluded from the analysis of variance.
[b] C = control; L = light burn; H = heavy burn.
[c] Pre- = 1985; Post- = 1986 + 1987.

effect and treatment-by-year interaction ($P<.10$). In addition to the pre- and post-burn difference, there was also a significant difference between mean cover estimates for the two post-burn years (Table 5).

Measurements of the amount of exposed mineral soil and rock suggest that treatment intensity was as intended (Figure 4). From pre-treatment values of less than 4% cover (exposed rock), the light, heavy, and re-burn treatments removed 15, 51, and 76% of all duff cover, respectively. These values are not directly comparable to those in Table 4, since they approximate the proportion of surface area with complete duff combustion rather than being a measure (with depth-of-burn pins) of the proportion of duff remaining. Nevertheless, they do show a corresponding pattern. Results of a ranked ANOVA show significant effects for treatment, year, and the treatment-by-year interaction (Table 5).

2.2 Species Number

Twenty-four different plant species were observed during pre-treatment sampling. Of these, four were observed only once. By 1987, an additional eight species had been recorded, including two that were observed on only one occasion. The 32 species included 5 conifers, 6 deciduous shrubs, 3 evergreen shrubs, 3 ferns, 14 non-graminoid herbs, and 1 grass. Total

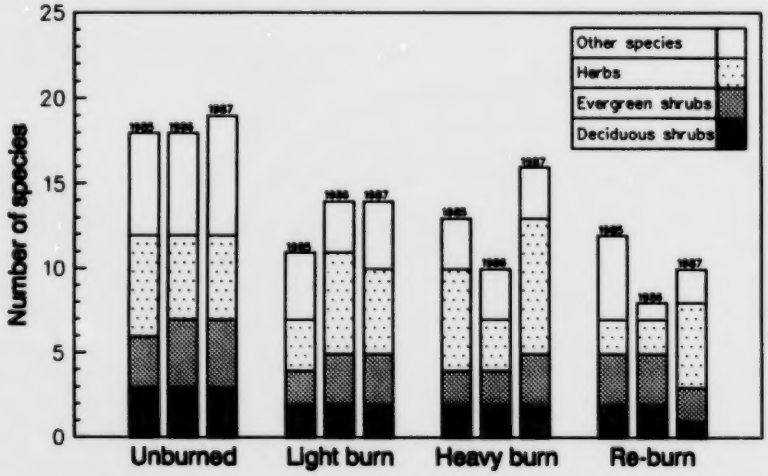

FIGURE 5. Species number in each of the four treatments during the first 3 years of sampling.

number of plant species present varied with treatment as well as time, as shown in Figure 5. A list of species recorded on the study plots is presented in Appendix 2.

During pre-treatment sampling, 18 different species were recorded in the control plots, compared to 11, 13, and 12 in the future light impact, heavy impact, and re-burn plots, respectively. The following year, total numbers stayed constant in the control, increased in the light burn, and declined in the heavy and re-burn plots. In 1987, total species numbers exceeded pre-treatment levels in all treatments except the re-burn. The greatest changes in numbers occurred in the herb component.

2.3 Species Abundance

Species abundance was examined in a number of ways. Initially, species were grouped into one of several lifeform categories and ANOVA's were performed on these groups. Subsequent analyses dealt with individual species. Because many species were present only in minute quantities on a low number of subplots, ANOVA's were conducted only on species present on at least 10% of all subplots. Analysis of variance results are presented in Table 5. Although frequency of occurrence is described for selected species, no specific tests were conducted on those data. The same applies to stem count information from several of the shrub species. Mean cover values and frequency of occurrence data for all species, organized by treatment and year, are listed in Appendix 3.

2.3.1 Conifers

In pre-treatment sampling, amabilis fir (Abies amabilis) and western hemlock (Tsuga heterophylla) were most abundant. Western redcedar (Thuja plicata) and Douglas-fir (Pseudotsuga menziesii) were also recorded on pre-burn plots, although the latter species was only observed once. Burning removed all amabilis fir and hemlock. Abundance of western redcedar and Douglas-fir increased following slashburning, primarily as a result of planting efforts. Yellow-cedar (Chamaecyparis nootkatensis) was also planted in the plots during the spring following burning, and was first recorded during the first post-treatment sampling.

Pre-treatment means of conifer cover ranged from 2 to 6% (Figure 6), with greatest cover values on the control and re-burn plots. In the two post-treatment measurements, cover on the burned plots did not exceed one-third of a percent, even though the areas were planted. The unburned (control) plots averaged 7.4 and 8.8% during post-treatment measurements, almost exclusively because of equal coverage of western

hemlock and amabilis fir. In the analysis of variance, there was a significant difference (P=.049) between pre-treatment and post-treatment conifer abundance.

2.3.2 Deciduous shrubs

Only three of the six deciduous shrubs observed were recorded during pre-treatment sampling; the others were first observed the year after treatment. The principal shrubs were red huckleberry (Vaccinium parvifolium), Alaskan blueberry (V. alaskaense), and trailing blackberry (Rubus ursinus). Baldhip rose (Rosa gymnocarpa), black raspberry (Rubus leucodermis), and thimbleberry (R. parviflorus) establishment occurred after treatment.

Deciduous shrub coverage ranged from 2.8 to 8.3% before treatment, with cover greatest on the control plot. Abundance on the unburned plots doubled in the next 2 years. Burning reduced shrub abundance to very low levels, but the shrubs had increased in abundance in the second post-treatment sampling. Analysis of variance procedures show significant differences between the unburned and burned treatments, and between pre- and post-treatment data, and also indicate a significant interaction effect (see Table 5).

Red huckleberry made up most of the deciduous shrub cover, so it is not surprising that the ANOVA results were similar. In the control plots, red huckleberry doubled in cover between 1985 and 1987 (Figure 7), but was markedly reduced in both percent cover and frequency by all levels of slashburning. The pattern of response was as anticipated: lower cover with increased fire intensity. Following treatment, red huckleberry was not observed on the re-burn plots and was rare on the heavy impact burn. Stem counts show an identical trend (Figure 8a).

Alaskan blueberry was less abundant than red huckleberry and responded similarly to burning. It was eliminated from both the heavy impact and re-burn treatments. A significant (P=.062) difference between pre- and post-treatment cover values was observed. However, stem count data (Figure 8b) were not as closely correlated to percent cover as they were for red huckleberry.

Trailing blackberry was found almost exclusively in the Cous Creek control plots (12 of 14 pre-treatment observations), although it was also recorded on the re-burn plots. On the unburned plots, cover values were first measured at 1.1%, increased to 2.8% in 1986, and increased again to 3.2% by the following year. In the re-burn plots, trailing

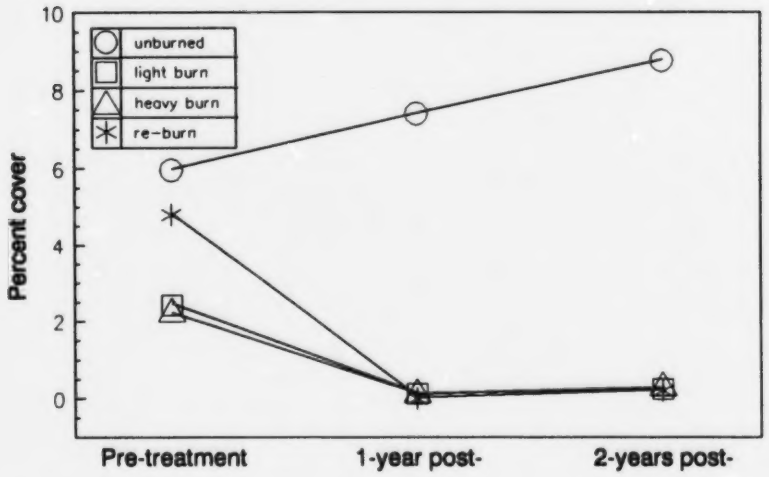

FIGURE 6. Percent cover of small conifers during the first 3 years of sampling on the four treatments.

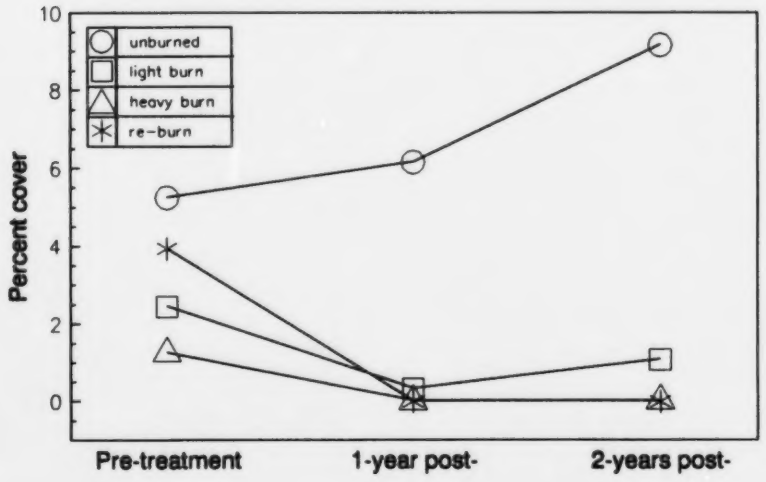

FIGURE 7. Percent cover of red huckleberry (Vaccinium parvifolium) during the first 3 years of sampling on the four treatments.

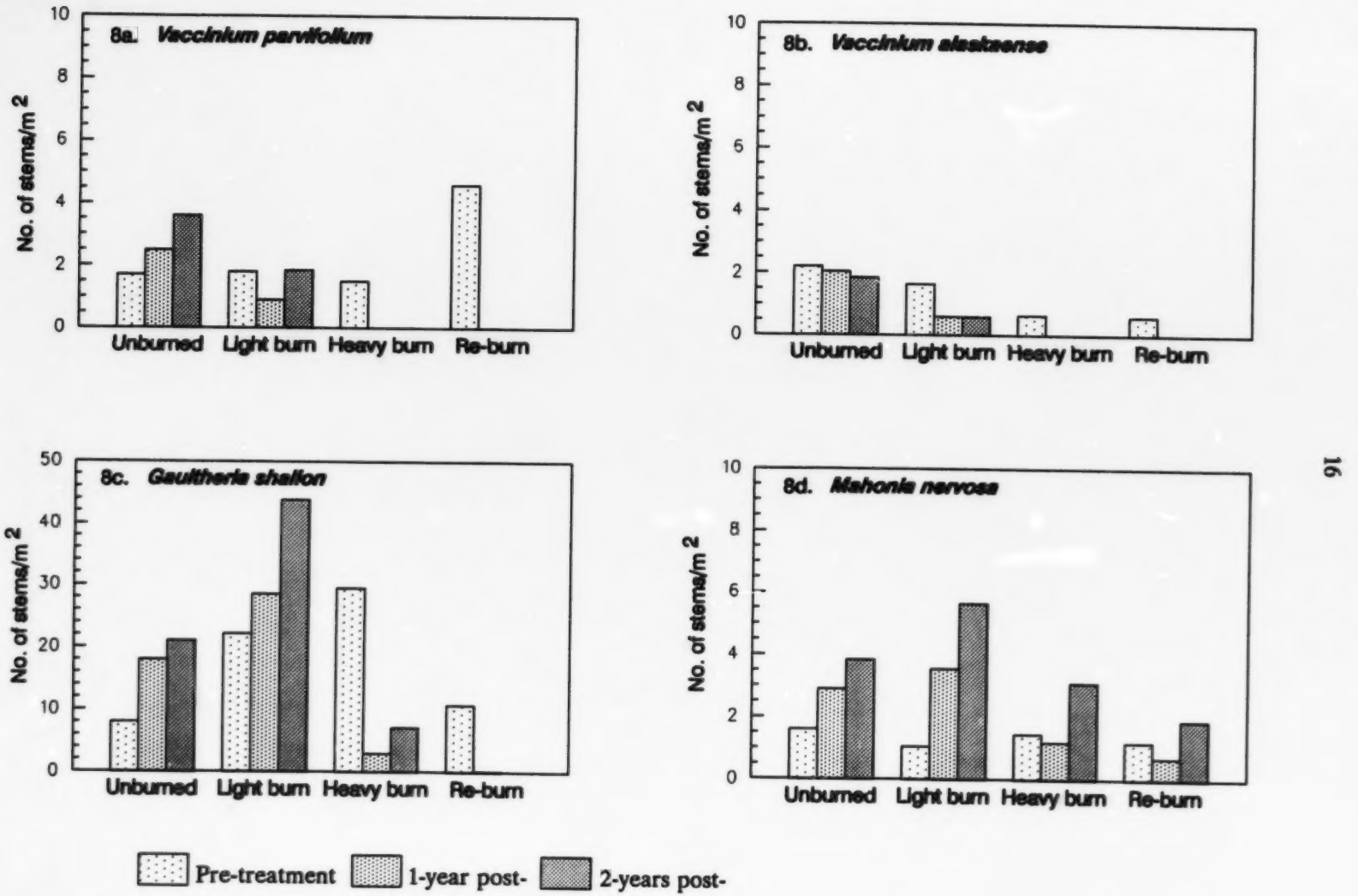

FIGURE 8a-d. Mean stem counts per square metre for selected shrub species.

blackberry cover declined following treatment (from 0.08 to 0.02%), but subsequently increased (to 0.5%) by 1987.

Of the other three deciduous shrubs, black raspberry showed the largest change in abundance. Absent on all areas before treatment, it was established on all treatments by 1987, having achieved cover values of 1.2 and 2.5% on the unburned and re-burned treatments, respectively.

2.3.3 Evergreen shrubs

Three evergreen shrubs were tallied during the 3 years of sampling. Salal (Gaultheria shallon) was the most abundant of these, followed by dull Oregon-grape (Mahonia nervosa) and twinflower (Linnaea borealis). Pre-burn values were highest and 1st-year post-burn values were lowest, as expected. There was wide variation in pre-treatment abundance, with cover ranging from 7.8 to 24.4% before burning. Analysis of variance on the data showed significant differences between pre- and post-treatment means ($P=.033$) and also between the two post-burn means ($P=.060$). There was also a significant interaction between year and treatment (Table 5).

The reduction in evergreen shrub cover increased with greater fire impact. Burning eliminated most of the cover on the heavy impact and re-burn treatments, but both treatments showed increasing cover in 1987. The light impact burn showed less change. Shrub cover declined to 10% in 1986 from 16.1% in 1985 following the light burn. In 1987, cover values had reached 16.7%, just exceeding the pre-treatment mean. On the unburned area, evergreen shrub cover increased from 10.3 to 21 between 1985 and 1987.

Because most of the evergreen shrub cover was salal, both year and interaction effects were also significant in the salal ANOVA. The interaction is easily seen in Figure 9. In the re-burn, only one subplot contained salal the year after treatment, but the year after that no salal was recorded. Stem counts yield a slightly different picture (Figure 8c) of overall salal response. The light burn had nearly twice as many stems in 1987 than in 1985, but only marginally greater ground cover. Burning apparently removed most of the larger salal plants, and the new growth that was present during post-treatment sampling had much smaller stem size, but was more numerous.

Percent cover of dull Oregon-grape showed significant year and interaction effects (Table 5), although the former were marginal. Oregon-grape coverage on the unburned

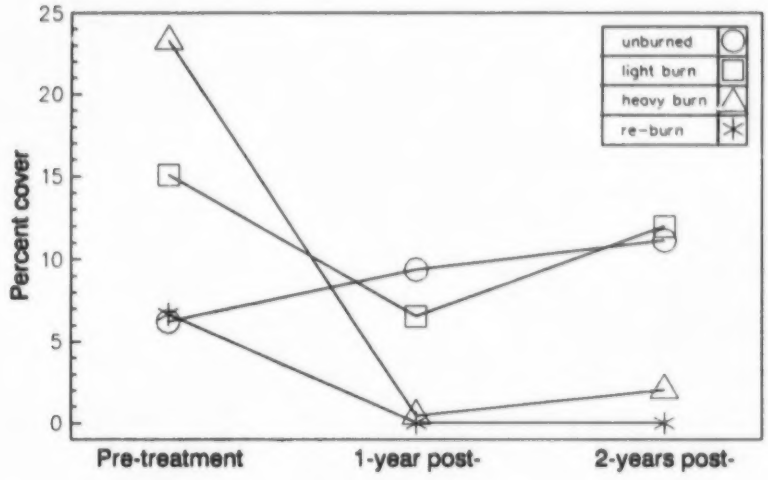

FIGURE 9. Percent cover of salal (Gaultheria shallon) during the first 3 years of sampling on the four treatments.

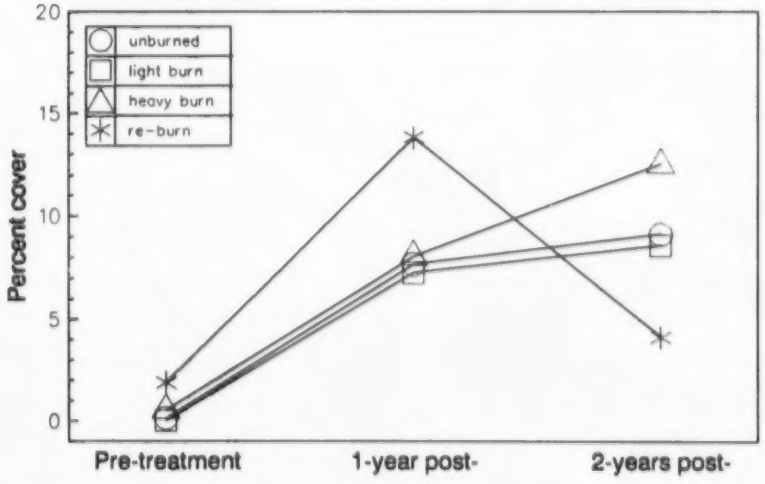

FIGURE 10. Percent cover of fireweed (Epilobium angustifolium) during the first 3 years of sampling on the four treatments.

plots increased from 1.8 to 3.8% between 1985 and 1987. The light burn showed a similar trend, increasing from 1.0 to 4.8% cover during the same period. Although the heavy impact burn showed an overall increase to 1.8%, the first post-burn assessment was 0.3% lower than the pre-burn value of 1.1%. In the re-burn treatment, the trend in cover showed a drop from 1.2 to 0.3% before increasing to 0.9% cover in 1987. Stem density values were remarkably similar to percent cover values, and exhibited a nearly identical trend (Figure 8d).

The third evergreen herb observed during the first 3 years of this study was twinflower. Although observed on both Cous Creek and Kanyon study sites, it was only present on the unburned control plots. Twinflower showed a steady increase in ground coverage from 1985 to 1987, with means of 2.3, 4.1, and 6.0% for the 3 years.

2.3.4 Herbs

Herb cover on the various treatments increased substantially after burning. Average cover increased from 1% in 1985 to 9.8% the following year and 12.9% the year after that. Analysis of variance showed significant differences between pre- and post-treatment means and between the means of the two post-treatment data sets (Table 5). Treatment and interaction effects were not significant ($P>.10$). Although 14 non-graminoid herbs were recorded on the study sites, very few of them contributed much to the cover total.

The most abundant herb was fireweed (Epilobium angustifolium), an early-succession perennial. It accounted for one-half of pre-burn herb cover and even more after treatment. Cover values differed significantly ($P=.0012$) between the pre- and post-burn data. Except for the re-burn, which was excluded from the ANOVA, there was little difference between treatments (Figure 10). The re-burn showed greater percent cover during the first 2 years of sampling, but decreased markedly in 1987. In pre-burn assessments, fireweed was most frequent on the re-burn plots at Macktush, accounting for 26 of 36 observations of the species on the 280 subplots sampled. Surprisingly, fireweed occurrence at that site was constant during all 3 years, while increasing substantially on the other treatments.

Other herbs that responded appreciably, if not significantly, were pearly everlasting (Anaphalis margaritacea), hairy cat's-ear (Hypochaeris radicata), wall lettuce

(Mycelis muralis), and common groundsel (Senecio vulgaris). Their changes in abundance are illustrated in Figure 11. Although absent or nearly so during pre-burn assessments, all four species showed a trend towards increasing cover on all treatments. Analysis of variance results on ranked data (Table 5) indicate a significant year effect for all but pearly everlasting. The cat's-ear and wall lettuce had significant differences between pre- and post-treatment means. The two post-treatment years were also significantly different. For wall lettuce, the unburned treatment differed from the burned ones (P=.047), and the light impact burn differed from the heavy impact burn (P=.046).

2.3.5 Other species groups

Specific responses of the moss, grass, and fern groups are not discussed in detail here. Data collection on moss cover was spotty, as mosses were noted only as indicators, unless one or more moss species contributed an appreciable amount to the total vegetative cover of a quadrat. Grasses, undifferentiated by species, were very rare, being observed on two subplots only in the re-burn treatment. Fern coverage was also very limited. Sword fern (Polystichum munitum) and deer fern (Blechnum spicant) were found on four and two subplots, respectively, while licorice fern (Polypodium glycyrrhiza) was recorded just once.

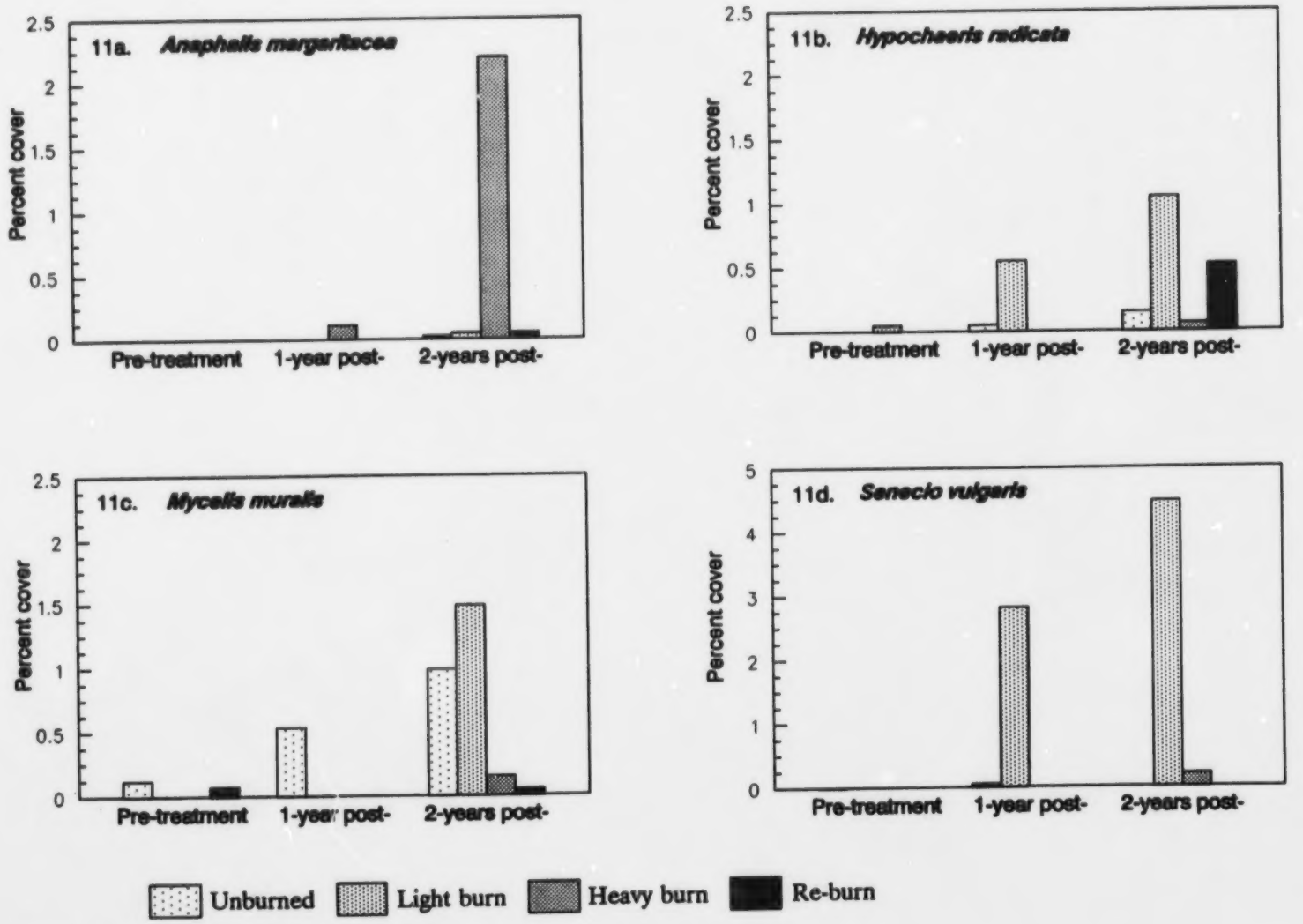

FIGURE 11a-d. Percent cover values of selected herb species, by year.

3 DISCUSSION

Examination of cover data collected before treatment and during the first 2 years after burning indicated notable changes in species abundance. Differences between unburned and burned treatments were seldom significant, probably due to both high variance in the pre-burn data and severe effects of even the light impact burn. Yearly cover values were significantly different, however, for most species. All species groups showed annual increases in cover on unburned plots, while only the herb group demonstrated a corresponding trend on the burned plots. As expected, fire impact was least on the light impact burn, and more species survived the light impact fire than survived on either the heavy impact or re-burn treatments. Although not included in the statistical analysis, the re-burn data were consistent with the response expected from a more severe burn.

Huckleberries were greatly reduced by all burn treatments, essentially surviving only on the light burns. Evergreen shrubs were also significantly influenced by burning. Unlike the deciduous shrubs, however, they showed a stronger rate of recovery. Rapid re-growth of both salal and dull Oregon-grape is probably a function of greater survival of below-ground portions of the plants and, in the case of salal, greater pre-burn abundance.

Treatment differences were minimal for most herbs, but differences between years were significant and consistent with a hypothesis of invasion. Lack of a fire-induced reduction in cover during the first post-treatment sampling is most likely a result of rapid colonization and not of tolerance to fire. Annual increases in cover were greatest for fireweed. However, fireweed was the only common species that showed an appreciable decline in cover in any treatment during the second post-burn (1987) sampling. Greater desiccation on the re-burn plots, resulting from a combination of warmer aspect and higher site moisture loss, is one possible explanation for the lower cover values. Future measurements may help to confirm this.

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APPENDIX 1. Vegetation sampling notes

a) Data collection notes :

Subplot (quadrat) position was designed to be the same for all plots. However, four subplot locations were changed to avoid MacMillan Bloedel's erosion-assessment stations. Changes were as follows:

CL4-06 (Cous Light burn Plot 4 Quadrat 6) was positioned at 19 m instead of 18 m.
CL4-18 (Cous Light burn Plot 4 Quadrat 18) was positioned at 4 m instead of 3 m.
KH5-18 (Kanyon Heavy burn Plot 5 Quadrat 18) was positioned at 4 m instead of 3 m.
MR3-02 (Macktush Re-burn Plot 3 Quadrat 2) was positioned at 5 m instead of 6 m.

- During the 1986 field season, fern frond length measurements were not taken.
- In 1986, it was decided that huckleberry stem measurements would only be taken on stems greater than 2 mm in diameter.
- In 1987, it was decided that counts of Oregon-grape would replace basal stem diameters.

APPENDIX 1. (Continued)

b) Data coding sheet information

1. Percent Cover

Column	1	Area (Cous, Kanyon, Macktush)
	2	Treatment (Control, Light, Heavy, Re-burn)
	3	Plot number (MB numbers 1-5)
	5-6	Quadrat (subplot) number (1-20)
	7	An asterisk (*) denotes a position change
	9	Line number (1-5) from the plot diagram
	10-11	Quadrat location, in metres, on the line
	12-17	Date (yy/mm/dd)
	18-24	Species code
	25-26	Percent cover: +1 (trace), 1-99
	27-35	as for columns 18-26
	36-44	as for columns 18-26
	45-53	as for columns 18-26
	54-62	as for columns 18-26
	63-71	as for columns 18-26

2. Measurements (for woody shrubs and evergreen ferns only)

Column	1	Area (Cous, Kanyon, Macktush)
	2	Treatment (Control, Light, Heavy, Re-burn)
	3	Plot number (MB numbers 1-5)
	5-6	Quadrat (subplot) number (1-20)
	7-12	Date (yy/mm/dd)
	13	Measurement type (1 = basal diameter in 0.1 mm, 2 = length in cm, 3 = stem count)
	14-20	Species code[a]
	21-23	Measurement #1
	24-80	Measurement #2 - #20

[a] Stem counts are used for Mahonia nervosa and lengths are taken for evergreen ferns. Basal diameters are used for all conifers and shrubs. For Vaccinium species, both basal stem diameters and lengths are taken. The measurements are paired.

APPENDIX 2. List of species code and scientific and common names of species used in this report

Species code[a]	Scientific name	Common name[b]	Lifeform[c]
ABIEAMA	Abies amabilis	amabilis fir	CNTR
ACHLTRI	Achlys triphylla	vanilla-leaf	HERB
ANAPMAR	Anaphalis margaritacea	pearly everlasting	HERB
BLECSPI	Blechnum spicant	deer fern	FERN
CHAMNOO	Chamaecyparis nootkatensis	yellow-cedar	CNTR
CIRSVUL	Cirsium vulgare	bull thistle	HERB
CORNCAN	Cornus canadensis	bunchberry	HERB
EPILANG	Epilobium angustifolium	fireweed	HERB
GAULSHA	Gaultheria shallon	salal	EVSH
GOODOBL	Goodyera oblongifolia	rattlesnake-plantain	HERB
GRASS		assorted grasses	GRAM
HYPORAD	Hypochaeris radicata	hairy cat's-ear	HERB
LINNBOR	Linnaea borealis	twinflower	EVSH
LISTCOR	Listera cordata	heart-leaved twayblade	HERB
MAHONER	Mahonia nervosa	dull Oregon-grape	EVSH
MYCEMUR	Mycelis muralis	wall-lettuce	HERB
POLYGLY	Polypodium glycyrrhiza	licorice fern	FERN
POLYMUN	Polystichum munitum	sword fern	FERN
PSEUMEN	Pseudotsuga menziesii	Douglas-fir	CNTR
ROSAGYM	Rosa gymnocarpa	baldhip rose	DCSH
RUBULEU	Rubus leucodermis	black raspberry	DCSH
RUBUPAR	Rubus parviflorus	thimbleberry	DCSH
RUBUURS	Rubus ursinus	trailing blackberry	DCSH
SENEVUL	Senecio vulgaris	common groundsel	HERB
TARAOFF	Taraxacum officinale	common dandelion	HERB
THUJPLI	Thuja plicata	western redcedar	CNTR
TIARLAC	Tiarella laciniata	cut-leaved foamflower	HERB
TIARTRI	Tiarella trifoliata	three-leaved foamflower	HERB
TRIELAT	Trientalis latifolia	broad-leaved starflower	HERB
TSUGHET	Tsuga heterophylla	western hemlock	CNTR
VACCALA	Vaccinium alaskaense	Alaskan blueberry	DCSH
VACCPAR	Vaccinium parvifolium	red huckleberry	DCSH
WOOD		woody material	SUBS
MINSOIL		mineral soil and rock	SUBS

[a] B.C. Ministry of Forests. 1980. Ministry of Forests vegetation coding list. Unpublished list compiled by B. D. Titus.

[b] Meidinger, D. V. 1988. Recommended vernacular names for common plants of British Columbia. B.C. Ministry of Forests. Internal report.

[c] CNTR = coniferous tree DCSH = deciduous shrub EVSH = evergreen shrub
FERN = fern or fern-ally GRAM = graminoid HERB = non-graminoid herb
SUBS = surface substrate

APPENDIX 3. Percent cover means for Sproat Lake plots

a) Unburned (control) plots in 1985

Species Code	Mean	Std Error	N	N>0
ABIEAMA	3.2762	1.41429	80	8
ACHLTRI	1.1	0.58774	80	6
ANAPMAR	0.	-	80	0
BLECSPI	0.0138	0.01255	80	2
CHAMNOO	0.	-	80	0
CIRSVUL	0.	-	80	0
CORNCAN	0.	-	80	0
EPILANG	0.15	0.09088	80	3
GAULSHA	6.225	1.35537	80	31
GOODOBL	0.0012	0.00125	80	1
GRASS	0.	-	80	0
HYPORAD	0.	-	80	0
LINNBOR	2.2637	0.85583	80	14
LISTCOR	0.	-	80	0
MAHONER	1.825	0.6172	80	16
MYCEMUR	0.1262	0.05728	80	6
POLYGLY	0.	-	80	0
POLYMUN	0.1875	0.13204	80	3
PSEUMEN	0.0012	0.00125	80	1
ROSAGYM	0.	-	80	0
RUBULEU	0.	-	80	0
RUBUPAR	0.	-	80	0
RUBUURS	1.1	0.42082	80	12
SENEVUL	0.0012	0.00125	80	1
TARAOFF	0.	-	80	0
THUJPLI	0.1262	0.12499	80	2
TIARLAC	0.	-	80	0
TIARTRI	0.0012	0.00125	80	1
TRIELAT	0.	-	80	0
TSUGHET	2.525	1.10579	80	12
VACCALA	1.9875	0.74364	80	16
VACCPAR	5.2625	1.48854	80	28
CONIFERS	5.9827	2.07959	80	19
D. SHRUBS	8.35	1.75285	80	46
E. SHRUBS	10.3138	1.75556	80	45
FERNS	0.2013	0.13239	80	5
HERBS	1.38	0.59116	80	16
MOSSES	0.	-	80	0
MINSOIL	4.125	1.72879	80	7
WOOD	52.2625	3.51064	80	80

APPENDIX 3. (Continued)

b) Unburned (control) plots in 1986

Species Code	Mean	Std Error	N	N>0
ABIEAMA	3.3263	1.38658	80	10
ACHLTRI	0.1875	0.10234	80	4
ANAPMAR	0.	-	80	0
BLECSPI	0.025	0.025	80	1
CHAMNOO	0.5125	0.43972	80	3
CIRSVUL	0.	-	80	0
CORNCAN	0.	-	80	0
EPILANG	7.7012	1.93875	80	22
GAULSHA	9.3625	1.72713	80	38
GOODOBL	0.	-	80	0
GRASS	0.	-	80	0
HYPORAD	0.05	0.03938	80	2
LINNBOR	4.075	1.50934	80	16
LISTCOR	0.	-	80	0
MAHONER	3.5375	1.07281	80	17
MYCEMUR	0.5388	0.22353	80	7
POLYGLY	0.	-	80	0
POLYMUN	0.3625	0.19262	80	4
PSEUMEN	0.	-	80	0
ROSAGYM	0.	-	80	0
RUBULEU	0.475	0.37986	80	4
RUBUPAR	0.	-	80	0
RUBUURS	2.825	0.85662	80	13
SENEVUL	0.0625	0.0625	80	1
TARAOFF	0.	-	80	0
THUJPLI	0.325	0.21404	80	3
TIARLAC	0.	-	80	0
TIARTRI	0.	-	80	0
TRIELAT	0.	-	80	0
TSUGHET	3.2638	1.47451	80	11
VACCALA	2.6887	0.97878	80	16
VACCPAR	6.1625	1.3827	80	38
CONIFERS	7.4275	2.06403	80	22
D. SHRUBS	12.1513	1.97373	80	56
E. SHRUBS	16.975	2.45639	80	53
FERNS	0.3875	0.19364	80	5
HERBS	8.54	2.02119	80	29
MOSSES	0.025	0.025	80	1
MINSOIL	4.25	1.65234	80	10
WOOD	45.625	3.60574	80	76

APPENDIX 3. (Continued)

c) Unburned (control) plots in 1987

Species Code	Mean	Std Error	N	N>0
ABIEAMA	3.9375	1.54749	80	8
ACHLTRI	0.5	0.2413	80	6
ANAPMAR	0.025	0.025	80	1
BLECSPI	0.15	0.12716	80	2
CHAMNOO	0.075	0.0527	80	2
CIRSVUL	0.	-	80	0
CORNCAN	0.	-	80	0
EPILANG	9.15	1.82737	80	35
GAULSHA	11.125	1.7536	80	40
GOODOBL	0.	-	80	0
GRASS	0.	-	80	0
HYPORAD	0.15	0.07568	80	5
LINNBOR	6.025	1.81624	80	19
LISTCOR	0.	-	80	0
MAHONER	3.85	1.17988	80	17
MYCEMUR	0.9875	0.36435	80	12
POLYGLY	0.	-	80	0
POLYMUN	0.4375	0.3351	80	2
PSEUMEN	0.0012	0.00125	80	1
ROSAGYM	0.	-	80	0
RUBULEU	1.1875	0.76122	80	4
RUBUPAR	0.	-	80	0
RUBUURS	3.225	0.97045	80	14
SENEVUL	0.	-	80	0
TARAOFF	0.	-	80	0
THUJPLI	1.05	0.6797	80	5
TIARLAC	0.	-	80	0
TIARTRI	0.	-	80	0
TRIELAT	0.	-	80	0
TSUGHET	3.725	1.39052	80	14
VACCALA	2.55	0.83778	80	14
VACCPAR	9.1762	1.89084	80	38
CONIFERS	8.7888	2.31727	80	22
D. SHRUBS	16.1387	2.31152	80	57
E. SHRUBS	21.	2.68617	80	57
FERNS	0.5875	0.35609	80	4
HERBS	10.8125	1.96835	80	41
MOSSES	0.	-	80	0
MINSOIL	2.8125	1.18283	80	7
WOOD	42.875	3.66278	80	74

APPENDIX 3. (Continued)

d) Light burn plots in 1985

Species Code	Mean	Std Error	N	N>0
ABIEAMA	1.825	0.70302	80	11
ACHLTRI	0.	-	80	0
ANAPMAR	0.	-	80	0
BLECSPI	0.	-	80	0
CHAMNOO	0.	-	80	0
CIRSVUL	0.	-	80	0
CORNCAN	0.	-	80	0
EPILANG	0.0375	0.0375	80	1
GAULSHA	15.065	2.13473	80	50
GOODOBL	0.	-	80	0
GRASS	0.	-	80	0
HYPORAD	0.	-	80	0
LINNBOR	0.	-	80	0
LISTCOR	0.	-	80	0
MAHONER	1.0387	0.5949	80	14
MYCEMUR	0.0012	0.00125	80	1
POLYGLY	0.	-	80	0
POLYMUN	0.3125	0.3125	80	1
PSEUMEN	0.	-	80	0
ROSAGYM	0.	-	80	0
RUBULEU	0.	-	80	0
RUBUPAR	0.	-	80	0
RUBUURS	0.	-	80	0
SENEVUL	0.	-	80	0
TARAOFF	0.1	0.1	80	1
THUJPLI	0.35	0.26808	80	2
TIARLAC	0.	-	80	0
TIARTRI	0.	-	80	0
TRIELAT	0.	-	80	0
TSUGHET	0.275	0.2503	80	3
VACCALA	1.4625	0.40758	80	14
VACCPAR	2.4637	0.86469	80	19
CONIFERS	2.45	0.7819	80	14
D. SHRUBS	3.9263	1.05683	80	28
E. SHRUBS	16.1038	2.13447	80	56
FERNS	0.3125	0.3125	80	1
HERBS	0.1387	0.10634	80	3
MOSSES	1.2	0.44058	80	16
WOOD	49.05	3.4875	80	77
MINSOIL	2.225	1.01679	80	7

APPENDIX 3. (Continued)

e) Light burn plots in 1986

Species Code	Mean	Std Error	N	N>0
ABIEAMA	0.	-	80	0
ACHLTRI	0.	-	80	0
ANAPMAR	0.0012	0.00125	80	1
BLECSPI	0.	-	80	0
CHAMNOO	0.025	0.025	80	1
CIRSVUL	0.025	0.025	80	1
CORNCAN	0.	-	80	0
EPILANG	7.2938	1.54342	80	44
GAULSHA	6.5375	1.03742	80	45
GOODOBL	0.	-	80	0
GRASS	0.	-	80	0
HYPORAD	0.55	0.28899	80	6
LINNBOR	0.	-	80	0
LISTCOR	0.	-	80	0
MAHONER	3.4513	0.9814	80	22
MYCEMUR	0.0025	0.00176	80	2
POLYGLY	0.	-	80	0
POLYMUN	0.3125	0.3125	80	1
PSEUMEN	0.	-	80	0
ROSAGYM	0.	-	80	0
RUBULEU	0.025	0.025	80	1
RUBUPAR	0.	-	80	0
RUBUURS	0.	-	80	0
SENEVUL	2.825	0.7849	80	18
TARAOFF	0.	0.	80	0
THUJPLI	0.125	0.08783	80	2
TIARLAC	0.	-	80	0
TIARTRI	0.	-	80	0
TRIELAT	0.	-	80	0
TSUGHET	0.	-	80	0
VACCALA	0.1387	0.07277	80	6
VACCPAR	0.3375	0.15906	80	8
CONIFERS	0.15	0.09088	80	3
D. SHRUBS	0.5012	0.19156	80	13
E. SHRUBS	9.9887	1.32413	80	57
FERNS	0.3125	0.3125	80	1
HERBS	10.6975	1.88346	80	50
MOSSES	0.	-	80	0
WOOD	30.75	3.82064	80	58
MINSOIL	14.6875	2.78352	80	36

APPENDIX 3. (Continued)

f) Light burn plots in 1987

Species Code	Mean	Std Error	N	N>0
ABIEAMA	0.	-	80	0
ACHLTRI	0.	-	80	0
ANAPMAR	0.05	0.03029	80	3
BLECSPI	0.	-	80	0
CHAMNOO	0.025	0.025	80	1
CIRSVUL	0.	-	80	0
CORNCAN	0.	-	80	0
EPILANG	8.6013	1.5752	80	46
GAULSHA	11.9625	1.72458	80	50
GOODOBL	0.	-	80	0
GRASS	0.	-	80	0
HYPORAD	1.0513	0.48841	80	11
LINNBOR	0.	-	80	0
LISTCOR	0.	-	80	0
MAHONER	4.7663	1.3955	80	27
MYCEMUR	1.4888	0.43605	80	17
POLYGLY	0.	-	80	0
POLYMUN	0.5625	0.5625	80	1
PSEUMEN	0.0625	0.0625	80	1
ROSAGYM	0.	-	80	0
RUBULEU	0.0375	0.0375	80	1
RUBUPAR	0.	-	80	0
RUBUURS	0.	-	80	0
SENEVUL	4.475	0.96783	80	37
TARAOFF	0.	-	80	0
THUJPLI	0.1875	0.13904	80	2
TIARLAC	0.	-	80	0
TIARTRI	0.	-	80	0
TRIELAT	0.	-	80	0
TSUGHET	0.	-	80	0
VACCALA	0.25	0.14507	80	4
VACCPAR	1.0775	0.50522	80	14
CONIFERS	0.275	0.153	80	4
D. SHRUBS	1.365	0.5292	80	17
E. SHRUBS	16.7288	2.06689	80	63
FERNS	0.5625	0.5625	80	1
HERBS	15.6663	1.90448	80	65
MOSSES	0.	-	80	0
WOOD	21.375	3.07601	80	51
MINSOIL	10.8125	2.52432	80	24

APPENDIX 3. (Continued)

g) Heavy burn plots in 1985

Species Code	Mean	Std Error	N	N>0
ABIEAMA	1.6	0.66718	80	10
ACHLTRI	0.19	0.12959	80	6
ANAPMAR	0.	-	80	0
BLECSPI	0.	-	80	0
CHAMNOO	0.	-	80	0
CIRSVUL	0.	-	80	0
CORNCAN	0.	-	80	0
EPILANG	0.5722	0.5072	79	6
GAULSHA	23.2637	3.01486	80	52
GOODOBL	0.	-	80	0
GRASS	0.	-	80	0
HYPORAD	0.05	0.03938	80	2
LINNBOR	0.	-	80	0
LISTCOR	0.0038	0.00214	80	3
MAHONER	1.125	0.30882	80	19
MYCEMUR	0.	-	80	0
POLYGLY	0.	-	80	0
POLYMUN	0.	-	80	0
PSEUMEN	0.	-	80	0
ROSAGYM	0.	-	80	0
RUBULEU	0.	-	80	0
RUBUPAR	0.	-	80	0
RUBUURS	0.	-	80	0
SENEVUL	0.	-	80	0
TARAOFF	0.	-	80	0
THUJPLI	0.4375	0.4375	80	1
TIARLAC	0.125	0.07626	80	3
TIARTRI	0.0025	0.00176	80	2
TRIELAT	0.	-	80	0
TSUGHET	0.1875	0.11813	80	4
VACCALA	1.5625	0.5905	80	13
VACCPAR	1.2625	0.38801	80	17
CONIFERS	2.225	0.79096	80	14
D. SHRUBS	2.825	0.67218	80	29
E. SHRUBS	24.3887	3.08565	80	54
FERNS	0.	-	80	0
HERBS	0.9363	0.53338	80	19
MOSSES	0.4375	0.3351	80	2
WOOD	53.725	3.81988	80	80
MINSOIL	1.125	1.125	80	1

APPENDIX 3. (Continued)

h) Heavy burn plots in 1986

Species Code	Mean	Std Error	N	N>0
ABIEAMA	0.	-	80	0
ACHLTRI	0.0125	0.0125	80	1
ANAPMAR	0.1137	0.05622	80	7
BLECSPI	0.	-	80	0
CHAMNOO	0.0625	0.05139	80	2
CIRSVUL	0.	-	80	0
CORNCAN	0.	-	80	0
EPILANG	8.0563	1.86217	80	52
GAULSHA	0.44	0.12799	80	17
GOODOBL	0.	-	80	0
GRASS	0.	-	80	0
HYPORAD	0.	-	80	0
LINNBOR	0.	-	80	0
LISTCOR	0.	-	80	0
MAHONER	0.7875	0.28501	80	10
MYCEMUR	0.	-	80	0
POLYGLY	0.	-	80	0
POLYMUN	0.	-	80	0
PSEUMEN	0.	-	80	0
ROSAGYM	0.0125	0.0125	80	1
RUBULEU	0.	-	80	0
RUBUPAR	0.	-	80	0
RUBUURS	0.	-	80	0
SENEVUL	0.	-	80	0
TARAOFF	0.	-	80	0
THUJPLI	0.0625	0.0625	80	1
TIARLAC	0.	-	80	0
TIARTRI	0.	-	80	0
TRIELAT	0.	-	80	0
TSUGHET	0.0012	0.00125	80	1
VACCALA	0.	-	80	0
VACCPAR	0.0125	0.0125	80	1
CONIFERS	0.1262	0.08028	80	4
D. SHRUBS	0.025	0.01757	80	2
E. SHRUBS	1.2275	0.35209	80	22
FERNS	0.	-	80	0
HERBS	8.1825	2.02119	80	29
MOSSES	0.45	0.43752	80	2
WOOD	23.15	3.16053	80	56
MINSOIL	51.25	4.21861	80	69

APPENDIX 3. (Continued)

i) Heavy burn plots in 1987

Species Code	Mean	Std Error	N	N>0
ABIEAMA	0.	-	80	0
ACHLTRI	0.025	0.01757	80	2
ANAPMAR	2.2012	0.6539	80	21
BLECSPI	0.	-	80	0
CHAMNOO	0.225	0.14117	80	4
CIRSVUL	0.	-	80	0
CORNCAN	0.0125	0.0125	80	1
EPILANG	12.5263	2.19779	80	56
GAULSHA	2.0012	0.92192	80	22
GOODOBL	0.	-	80	0
GRASS	0.	-	80	0
HYPORAD	0.0625	0.04112	80	3
LINNBOR	0.	-	80	0
LISTCOR	0.	-	80	0
MAHONER	1.8512	0.62792	80	15
MYCEMUR	0.1532	0.09022	79	5
POLYGLY	0.	-	80	0
POLYMUN	0.	-	80	0
PSEUMEN	0.0138	0.01255	80	2
ROSAGYM	0.025	0.025	80	1
RUBULEU	0.125	0.125	80	1
RUBUPAR	0.	-	80	0
RUBUURS	0.	-	80	0
SENEVUL	0.2125	0.18801	80	3
TARAOFF	0.	-	80	0
THUJPLI	0.0625	0.0625	80	1
TIARLAC	0.	-	80	0
TIARTRI	0.	-	80	0
TRIELAT	0.0125	0.0125	80	1
TSUGHET	0.	-	80	0
VACCALA	0.	-	80	0
VACCPAR	0.025	0.01757	80	2
CONIFERS	0.3013	0.15393	80	6
D. SHRUBS	0.175	0.128	80	4
E. SHRUBS	3.8525	1.23214	80	30
FERNS	0.	-	80	0
HERBS	15.2038	2.21983	80	69
MOSSES	1.	1.	80	1
WOOD	21.25	3.12009	80	46
MINSOIL	53.125	4.44674	80	61

APPENDIX 3. (Continued)

j) Re-burn plots in 1985

Species Code	Mean	Std Error	N	N>0
ABIEAMA	0.625	0.39821	40	4
ACHLTRI	0.	-	40	0
ANAPMAR	0.	-	40	0
BLECSPI	0.	-	40	0
CHAMNOO	0.	-	40	0
CIRSVUL	0.	-	40	0
CORNCAN	0.	-	40	0
EPILANG	1.9025	0.34458	40	26
GAULSHA	6.675	2.38139	40	12
GOODOBL	0.	-	40	0
GRASS	0.075	0.05533	40	2
HYPORAD	0.	-	40	0
LINNBOR	0.	-	40	0
LISTCOR	0.	-	40	0
MAHONER	1.175	0.72048	40	6
MYCEMUR	0.0775	0.05529	40	3
POLYGLY	0.025	0.025	40	1
POLYMUN	0.	-	40	0
PSEUMEN	0.	-	40	0
ROSAGYM	0.	-	40	0
RUBULEU	0.	-	40	0
RUBUPAR	0.	-	40	0
RUBUURS	0.0775	0.07498	40	2
SENEVUL	0.	-	40	0
TARAOFF	0.	-	40	0
THUJPLI	0.175	0.175	40	1
TIARLAC	0.	-	40	0
TIARTRI	0.	-	40	0
TRIELAT	0.	-	40	0
TSUGHET	4.025	2.25789	40	4
VACCALA	0.225	0.20092	40	2
VACCPAR	3.9525	1.6593	40	22
CONIFERS	4.825	2.35908	40	8
D. SHRUBS	4.255	1.66175	40	24
E. SHRUBS	7.85	2.53047	40	16
FERNS	0.025	0.025	40	1
HERBS	1.98	0.34973	40	26
MOSSES	3.475	1.60408	40	11
WOOD	31.45	3.92754	40	39
MINSOIL	3.25	2.54164	40	3

APPENDIX 3. (Continued)

k) Re-burn plots in 1986

Species Code	Mean	Std Error	N	N>0
ABIEAMA	0.	-	40	0
ACHLTRI	0.	-	40	0
ANAPMAR	0.0025	0.0025	40	1
BLECSPI	0.	-	40	0
CHAMNOO	0.	-	40	0
CIRSVUL	0.	-	40	0
CORNCAN	0.	-	40	0
EPILANG	13.825	2.77047	40	26
GAULSHA	0.0025	0.0025	40	1
GOODOBL	0.	-	40	0
GRASS	0.	-	40	0
HYPORAD	0.	-	40	0
LINNBOR	0.	-	40	0
LISTCOR	0.	-	40	0
MAHONER	0.35	0.19791	40	3
MYCEMUR	0.	-	40	0
POLYGLY	0.	-	40	0
POLYMUN	0.	-	40	0
PSEUMEN	0.025	0.025	40	1
ROSAGYM	0.	-	40	0
RUBULEU	0.75	0.63423	40	2
RUBUPAR	0.0025	0.0025	40	1
RUBUURS	0.025	0.025	40	1
SENEVUL	0.	-	40	0
TARAOFF	0.	-	40	0
THUJPLI	0.	-	40	0
TIARLAC	0.	-	40	0
TIARTRI	0.	-	40	0
TRIELAT	0.	-	40	0
TSUGHET	0.	-	40	0
VACCALA	0.	-	40	0
VACCPAR	0.	-	40	0
CONIFERS	0.025	0.025	40	1
D. SHRUBS	0.7775	0.63641	40	3
E. SHRUBS	0.3525	0.19781	40	4
FERNS	0.	-	40	0
HERBS	13.8275	2.77015	40	27
MOSSES	0.125	0.125	40	1
WOOD	16.875	4.20122	40	19
MINSOIL	75.625	5.0006	40	37

APPENDIX 3. (Concluded)

l) Re-burn plots in 1987

Species Code	Mean	Std Error	N	N>0
ABIEAMA	0.	-	40	0
ACHLTRI	0.	-	40	0
ANAPMAR	0.05	0.05	40	1
BLECSPI	0.	-	40	0
CHAMNOO	0.	-	40	0
CIRSVUL	1.85	1.33328	40	4
CORNCAN	0.	-	40	0
EPILANG	4.1575	0.99184	40	29
GAULSHA	0.	-	40	0
GOODOBL	0.	-	40	0
GRASS	0.075	0.075	40	1
HYPORAD	0.525	0.29955	40	4
LINNBOR	0.	-	40	0
LISTCOR	0.	-	40	0
MAHONER	0.9	0.46105	40	6
MYCEMUR	0.055	0.04999	40	3
POLYGLY	0.	-	40	0
POLYMUN	0.	-	40	0
PSEUMEN	0.	-	40	0
ROSAGYM	0.	-	40	0
RUBULEU	2.5	2.25747	40	2
RUBUPAR	0.	-	40	0
RUBUURS	0.5	0.39223	40	2
SENEVUL	0.	-	40	0
TARAOFF	0.	-	40	0
THUJPLI	0.225	0.14091	40	3
TIARLAC	0.	-	40	0
TIARTRI	0.	-	40	0
TRIELAT	0.	-	40	0
TSUGHET	0.	-	40	0
VACCALA	0.	-	40	0
VACCPAR	0.	-	40	0
CONIFERS	0.225	0.14091	40	3
D. SHRUBS	3.	2.40059	40	3
E. SHRUBS	0.9	0.46105	40	6
FERNS	0.	-	40	0
HERBS	6.6375	1.65347	40	35
MOSSES	0.	-	40	0
WOOD	15.625	4.07536	40	18
MINSOIL	73.	5.71996	40	35